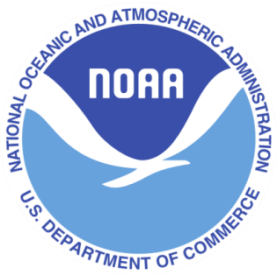


Earth System Prediction Capability (ESPC)

Daniel Eleuterio

21 March 2012

What is ESPC?

Coupled global analysis and prediction framework at accuracies and timescales beyond traditional synoptic weather forecasts.

More than just a model. An approach towards advanced understanding and systems-based prediction leveraging multiple U.S. national efforts

ESPC Partners

ESPC membership incorporates development efforts from various sectors of the US including federal research centers and federally and privately sponsored academic groups.

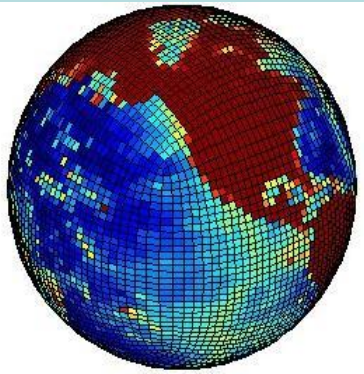
Principal Partners

- Department of Commerce
  - National Oceanic and Atmospheric Administration (NWS, OAR)
- Department of Defense
  - U.S. Navy (Oceanographer of the Navy, CNMOC, ONR, NRL)
  - U.S. Air Force (Director of Air Force Weather, AFWA)
- Department of Energy (DOE) Office of Science
  - Office of Biological and Environmental Research (BER/CESD)
- National Aeronautics and Space Administration (NASA)
  - Earth Science Division, Science Mission Directorate
- National Science Foundation (NSF) (under consideration)
  - Geosciences Directorate (GEO)

Approach

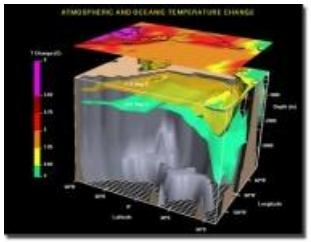
Seek Sources of Predictability through Improved Model Physics

- Coupled modeling
- Improved resolution & parameterization



Improve Initial Value Problem through

- Joint observational retrievals
- New hybrid DA approaches

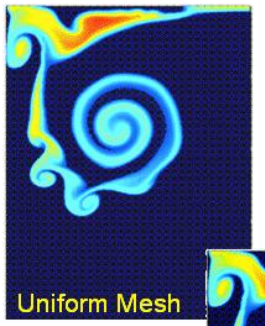


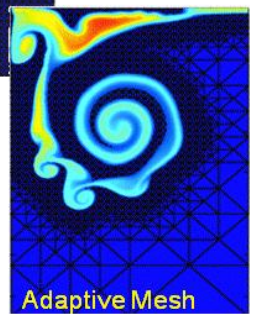
Increase Forecast Information through

- Stochastic prediction and post-model processing
- National Multi-model ensembles
- Seamless prediction

Increase System Resolution affordably through

- Efficient Computational Architectures
- Efficient Numerics/ Discretization





ESPC Timeline

2012 — Agency partnerships formalized, management identified, develop science and resource cases, initiate architecture and resource committees

2013 — ESPC program initiation, shared resources identified, Demonstration framework plans initiated, proposals for demos & framework maintenance. Initiate science meetings for advanced capability.

2015 — Demonstrations of advanced prediction goals. Initial coupling of current capabilities under NUOPC/ESMF standards

2016 — Review of demonstrations, definition of ESPC science and technology issues, initiate ESPC design.

ESPC FOC

National operational earth system prediction capability for meeting multi-agency mission requirements

Recapitalization of operational model suite through multi-agency research and development partnership

Improved near-term to decadal predictability of the physical environment

2018 — **ESPC IOC** – Demos transitioned

2019 — Development of ESPC/technology recapitalization. Plan for FOC System. Identify FOC computational requirements.

2021 — Implement at operational prediction centers

2025 — **ESPC FOC**

Proposed
Joint ESPC Demonstrations

Weekly to monthly episodic weather extremes

Prediction of stationary planetary waves and wave transitions on time scales of a week to six weeks leading to reliable prediction of extreme heat waves, flooding, and drought based on planetary teleconnections and coupling of ocean, land, ice and space.

Seasonal tropical cyclone activity and track/threat probability

Improved seasonal predictions of tropical cyclone activity, number of storms, major storms and genesis by basin and region of basin based on improved ENSO/MJO and other ISI variability prediction

Seasonal coastal seas prediction

Prediction of monthly to seasonal river runoff leading to prediction of salinity, nutrient loading, hypoxia/algal bloom events from improved prediction of precipitation extremes based on planetary waves and MJO/ENSO skill

Annual to decadal Arctic sea ice conditions

Prediction of annual to decadal sea ice extent and ice free dates based on coupling of ocean and atmosphere with improved ice models

Decadal climate variation

Improved prediction of the Atlantic Meridional Overturning Circulation as a driver for decadal climate variability

WORKSHOP GOALS

- To achieve a better understanding of ESPC objectives and activities,
- To identify overlap and/or potential collaboration with USGCRP activities,
- To validate and develop more detail for the five proposed ESPC demonstration projects, and,
- To establish science working groups for these demonstration projects.

Questions - Science

Adapted from T. Hamill, S. Harper

What are the appropriate techniques for generating (ensemble or deterministic) initial conditions for coupled model states?

For IVP limited forecast problems, how do we simultaneously create sets of perturbed initial conditions for the ocean, atmosphere, land, cryosphere, etc.?

How do we carry uncertainty in each earth-system component through the coupled system, and control BVP feedback and error growth in a global coupled system?

For what forecast problems and ranges are stochastic parameterizations (vs. stochastic initial conditions) appropriate, and how do we make these parameterizations represent model uncertainty?

Questions - Science

Adapted from T. Hamill, S. Harper

How do multi-model approaches and statistical post-processing contribute to (or detract from) improved predictability and estimates of uncertainty.

Exploiting sources of predictability for extended range prediction will only inform certain forecast problems. How do we communicate this to decision makers who are used to more generalizable forecasts?

The ability to skillfully exploit sources of predictability in the ESPC demonstrations at ISI timescales is our hypothesis; how do we best articulate, and measure, the desired outcomes of these demos and establish if they are an appropriate baseline for the future improvements that ESPC will provide?

Questions – End State

One of the goals of ESPC is to demonstrate extended range forecast skill (roughly 7 days to seasonal, annual, and beyond) by exploiting sources of predictability and a coupled systems approach.

- What requirements or customer demand are there now for products beyond a 5-7 day forecast?
- How are these requirements currently met?
- What initiatives do production centers have for improved products?
- How might measures of forecast skill for synoptic and extended range products differ?

How accepting are decision makers of probabilistic forecasts? What challenges are there with credibility, communication, customer education and buy-in? What initiatives and technical approaches are most promising?

Next Steps

- Establish program office and agencies' approval on revised charter (Jan 12)
- Form working groups for Demonstrations (Mar 12)
- Expand NUOPC common modeling architecture committee to address ESPC (Mar 12)
- Further define/ validate demonstrations – resources, science & tech issues, data requirements, models involved, potential outcomes, success criteria, user benefit, IOC (Jun 12)
- Brief Executive Steering Group on resources required, definitive roadmap, end state, user benefit (July 12)
- Community outreach and engagement

End State

IOC 2018

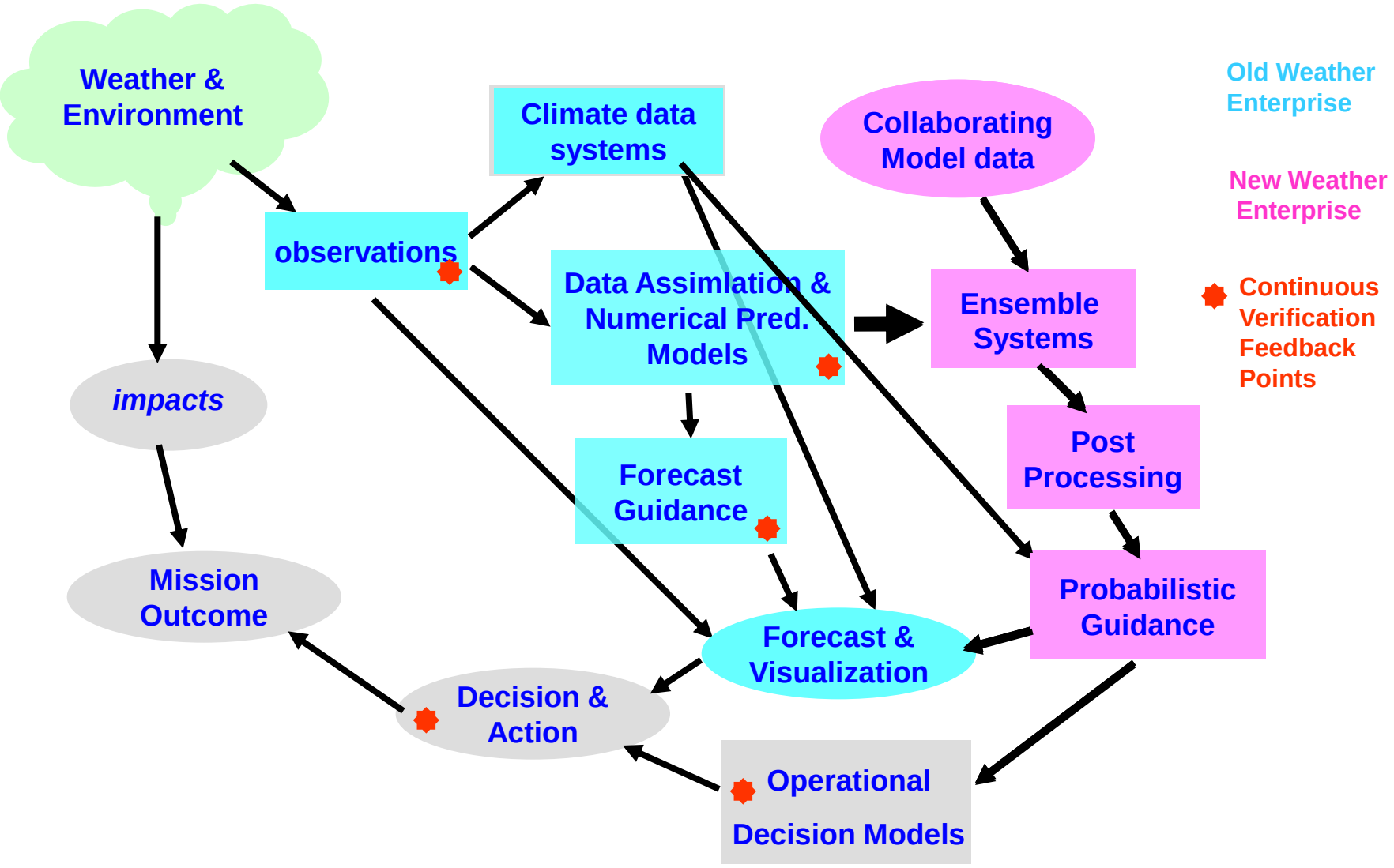
- Successful demonstration of five predictive goals using research models
- Commence transition of technological advancements into existing prediction systems (CFS, NAVGEM, NUE)
- New paradigm for meeting multi-agency mission requirements
- Enhanced National capability created via partnering

FOC 2025

- Recapitalization of operational model suite
- Advanced, community-based forecast systems for R&D
- Advanced, National forecast system for operations

QUESTIONS?

Adding Uncertainty to the Forecast



Backup Slides